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(54) Title: TEA FORTIFIED WITH IRON

(57) Abstract: The present invention provides tea fortified with a ferrous-plant protein hydrolysate complex. The complex does not cause precipitation of iron-polyphenol; complexes in the tea and is also bioavailable. A tea drink made from the tea of the invention has an attractive colour.

WO 03/032741 A1

TEA FORTIFIED WITH IRON

The present invention relates to tea fortified with an iron-plant protein complex that is stable and also bio-absorbable and to a process for making fortified tea.

BACKGROUND AND PRIOR ART:

Iron deficiency is common in the population. Though the recommended dietary intake is 28-30 mg per day, depending on age and sex, more than 1/6th of the global population is known to suffer from nutritional iron deficiencies. Anaemia is a common result of iron deficiency.

Fortification of food with iron is one way of providing iron to deficient populations. This is particularly required in developing countries like India where the average iron intake is only 50-80% of the recommended dietary intake. Further, in India this iron is only available as non-haem iron as a large section of the population of the country is vegetarian.

Common sources of iron used for fortification of food and beverages include ferrous sulphate, ferrous, lactate, ferrous gluconate and ferrous citrate. Iron in the soluble form is preferred as non-soluble or slightly soluble iron sources like elemental iron and some ferric salts show poor bioabsorption.

Tea is a popular, cheaply available beverage consumed throughout the world. Fortifying tea with iron compounds would therefore be an excellent way of providing iron. However, fortification of tea with a soluble iron source has always been a problem as polyphenols present in tea complex with iron compounds to give insoluble iron-polyphenol complexes which precipitate during the preparation of tea beverages. Additionally, the tea liquor produced has a colour that is dark and undesirable.

Encapsulated iron compounds or iron complexes are reported in the prior art. These are expected to reduce the reactivity of iron as well as increase bioavailability. For example US 3969540, US 4020158, US 4172072 and US 4216144 relate to metal-proteinate complexes and methods of making them. Stable ferrous or ferric

complexes with casein, collagen, albumen, soy or gelatin are reported. The complexes can be used as an iron source for plant or animal feed.

WO 0051447 (Societe des Produits Nestle S.A.) relates to iron-protein complexes, wherein the protein is hydrolysed egg white protein of molecular weight in the range of about 500 to 10,000 and the iron source is a ferrous salt. The complexes can be used to fortify foods and beverages and are specifically directed towards fortifying chocolate containing beverages. The fortification of a sterilised liquid tea beverage by the complex is also claimed.

WO 0051446 (Societe des Produits Nestle S.A.) pertains to ferric-caseinate complexes which can be used for fortifying polyphenol containing beverages. The invention is particularly directed towards chocolate drinks. The iron complex can also be used for fortifying a retorted liquid tea beverage.

Thus the prior art is directed towards the use of iron-protein complexes wherein the protein is from an animal source. In a country like India, where the population is predominantly vegetarian, animal protein cannot be used for fortification. World-wide too there is a preference for plant products as opposed to animal products. Further the prior art complexes can be used for fortifying beverages. However, the prior art is principally directed towards chocolate drinks and powders and do not solve the problems associated with the iron fortification of tea like precipitation, unattractive colour and poor bioabsorbability.

The present inventors have now found that it is possible to provide for iron-plant protein complexes that are stable and can be readily incorporated in tea. The iron compound is a ferrous salt and the plant protein is a hydrolysed protein. The complexes are stable and can be incorporated during the process of black tea manufacture. They may also be suitably used in ready to drink, water soluble tea powders or liquid tea beverages. The tea liquor obtained has good colour and clarity and none of the poor visual and sensory attributes associated with iron fortified teas known hereto.

SUMMARY OF THE INVENTION:

Thus the present invention relates to ferrous-hydrolysed plant protein complexes that can be suitably used to fortify tea. The plant protein can be obtained from any part of the plant. Examples of hydrolysed plant protein include those obtained from cereals and legumes like wheat, rye, corn, barley and pea. The complexes can be incorporated into tea during or after black tea manufacture as well as during or after the manufacture of ready to drink powders. The complexes may also suitably be used in liquid tea beverages. The tea liquors obtained by using the fortification system of the invention show good colour and good clarity and the ferrous-hydrolysed plant protein is readily bio-absorbable.

DETAILED DESCRIPTION OF THE INVENTION:

Throughout the specification, all parts are by weight unless otherwise specified.

According to the first aspect of the invention, there is provided a tea fortified with a stable ferrous-hydrolysed plant protein complex wherein the average molecular weight of the hydrolysed protein is 250D to 5000 D (preferably 500D to 5000D).

Preferably the ratio of the ferrous ion to the hydrolysed plant protein is from 1:3 to 1:13, more preferably from 1:6 to 1: 13, and most preferably from 1:10 to 1:13.

As used herein "tea" is black leaf tea, ready to drink tea powders and liquid tea drinks.

According to a second aspect of the invention, there is provided a process to make fortified with a ferrous-hydrolysed plant protein complex comprising the steps of preparing an acidic solution of the hydrolysed plant protein such that the pH is preferably from 1 to 5, adding a ferrous salt to the solution, changing the pH to an alkaline pH, preferably from 6.8 to 10, heating the mixture, and optionally drying the mixture to obtain the complex and adding the complex to a tea product.

The mixture can be dried by any suitable means. Spray drying is an especially preferred method.

The process of tea manufacture comprises the steps of:

a. withering
b. maceration
c. fermentation and
d. drying

Black tea is obtained at the end of the process. The ferrous-hydrolysed plant protein complex can be added at any step after fermentation, including to the black tea that is manufactured.

The source of ferrous iron for use in the process of the invention is essentially a ferrous salt. Suitable food grade ferrous salts that can be used include ferrous sulphate, ferrous chloride, ferrous citrate, ferrous lactate or ferrous fumarate or their mixtures thereof. Especially preferred is ferrous sulphate.

Ferric salts cannot be used as an effective iron source since they tend to precipitate out of solution very rapidly as the pH is increased above 2. Once precipitated, they become inert and do not react with tea polyphenols. Due to this reason, the colour and appearance of an end-cup of tea made with tea fortified with a ferric salt (after the pH has been increased above 2) looks like that of a regular cup of tea. However, the precipitated ferric iron is not available to the body to any significant amount due to its extremely limited solubility. If, on the other hand, ferric salts are added to tea without increasing their pH above 2, the colour of the tea becomes very dark due to the reaction of the ferric ions with the tea polyphenols.

Preferably, the amount of ferrous-hydrolysed plant protein complex added to the tea is sufficient to give 0.15% to 0.3% ferrous ion based on the total weight of the tea solids present.

The term hydrolysed plant protein refers to the hydrolysed products of plant protein ranging from long chain polypeptides to amino acids.

In one preferred embodiment, the hydrolysed plant protein has an average molecular weight of 500 D to 5000 D.

The plant protein can be obtained from any part of the plant like seeds, tubers, stem, leaves etc. Preferably the plant protein is obtained from the seed. The plant protein can be obtained from a cereal or a legume.

Hydrolysed plant proteins that are suitable for the invention include those obtained from wheat, pea, rye, barley, corn etc. The hydrolysed plant protein can be commercially obtained or the protein hydrolysate can be made by enzymatically or chemically hydrolysing the protein.

The ferrous - hydrolysed plant protein complex of the invention is suitably formed by the following process.

The hydrolysed plant protein, either obtained commercially or obtained by chemical or enzymatic hydrolysis of a plant protein is dissolved in an acid medium. Preferably the pH of the acid medium is from 1 to 5, more preferably from 2 to 4. Both organic and inorganic acids are suitable to prepare the acid medium. The ferrous salt is then added to the acid medium. The pH of the mixture is then raised by using a suitable base. Preferably the pH is between 6.8 and 10, more preferably between 6.8 and 8. The mixture is then optionally heated to a temperature of at least 50°C. The mixture is then dried by conventional means to get the ferrous-hydrolysed plant protein complex in a powder form. Spray drying is an especially preferred method of drying.

The powder can be used in the solid form or reconstituted with water and added during the processing of tea.

The ferrous-hydrolysed plant protein complex is stable and do not lead to off flavours or discoloration when added to tea. The complex is also readily bio-absorbable and can provide for the required recommended intake of iron.

The ferrous-hydrolysed plant protein complex is used to fortify tea, especially black tea. The complex can also be incorporated in ready to drink tea powders as well as liquid tea drinks.

Black tea manufacture involves the steps of withering, maceration, fermentation and drying. The complex can be added at any step after fermentation. The complexes can also be added to black tea prepared by the above process.

The fortified black tea obtained can be further processed to obtain water soluble, ready to drink tea powders or liquid tea beverages.

Other components including flavours, sweeteners, herbal extracts, vitamins, vegetable or animal protein, carbohydrates, minerals can be added to the fortified tea products mentioned above without affecting the sensory and visual properties of tea.

The invention is now demonstrated by the following non-limiting examples.

Comparative Example A

An aqueous solution of papain is made. The pH is then adjusted to 3.28 using orthophosphoric acid. Ferrous sulphate is then added to the solution. The pH is adjusted to 7.1 to 9 using ammonium hydroxide. The solution is then heated at 80 degrees centigrade followed by spray drying. The ferrous-papain complex is obtained as a powder. The ratio of the ferrous salt to the papain is 1:117. The complex was added to commercially available A1 black leaf tea to give a fortified black tea product containing 0.15% by weight of ferrous ion.

Example 1

200g glutamine peptide hydrolysed (a hydrolysed wheat protein – average molecular weight 690D - obtained from DMV International, Netherlands under product code WGE80GPN) is dissolved in 450 g of water. The pH is then adjusted to 3.28 using ortho phosphoric acid. 15g ferrous sulphate is added to the solution. The pH is adjusted to 7.1 using ammonium hydroxide. The solution is heated at 80 degrees centigrade till the contents were homogenous. The solution is then spray dried. The

ferrous-glutamine peptide complex is obtained as a powder. The ratio of the ferrous salt to the glutamine peptide is 1:13.33. The complex was added to commercially available A1 black leaf tea to give a fortified black tea product containing 0.15% by weight of ferrous ion.

Example 2

200g glutamine peptide hydrolysed (a hydrolysed wheat protein – average molecular weight 690D - obtained from DMV International, Netherlands under product code WGE80GPN) is dissolved in 450g of water. The pH is then adjusted to 3.1 using ortho phosphoric acid. 60g ferrous sulphate is added to the solution. The pH is adjusted to 7.5 using ammonium hydroxide. The solution is heated at 80 degrees centigrade till all the contents are homogenous. The solution is then spray dried. The ferrous-glutamine peptide complex is obtained as a powder. The ratio of the ferrous salt to the glutamine peptide is 1:3.33. The complex was added to commercially available A1 black leaf tea to give a fortified black tea product containing 0.15% by weight of ferrous ion.

Comparative Examples B and C.

A1 black tea containing no added iron (Example B) was used as a control in the experiments reported herein. Ferrous sulphate was added to A1 black tea procured from the market to give Comparative Example C containing 0.15% by weight of ferrous ion.

The details of the above examples are presented in Table 1.

Table 1

Example	Iron Source/Amount of iron	Amount of added Fe (not the iron salt) (% wrt tea)
B	-	0
C	$FeSO_4$	0.15
A	$FeSO_4$ + papain	0.15
1	$FeSO_4$ + glutamine peptide (1:13.33)	0.15
2	$FeSO_4$ + glutamine peptide (1:3.33)	0.15

Evaluation of tea:

Colour of end-cup: To the mixture of 150 ml of milk and 100 ml of water was added 5 gms of the tea of Comparative Example B and 10 gms of sugar and the mixture boiled for 3 minutes. The tea was then filtered and the colour measured on a Minolta Reflectance Meter. Colour is measured and represented by three colour dimensions, L*, a* and b*. L* represents paleness/darkness, with L = 0 being black and L = 100 being white or colourless. a* represents redness/greeness, with high positive values of a* being red and high negative values of a* being green. B* represents blueness/yellowness, with high positive values of b* being yellow and high negative values of b* being blue.

The procedure was repeated for the teas of Comparative Examples C and A and Example 1 and 2.

The details of the study are as presented in Table 2.

Table 2

Example	Iron Compound	L*	A*	B*	Observations
B	-	56	7.1	21.8	Regular / normal colour of tea
C	$FeSO_4$	43.7	5.5	6.6	Dark greyish black colour in tea end-cup made with milk
A	Fe SO_4 + papain	51	5.4	15.1	Brownish color. Chemical note ; off taste.
1	$FeSO_4$ + glutamine peptide (1:13.33)	56	7.1	20.4	Colour on par with control tea. No off notes
2	$FeSO_4$ + glutamine peptide (1:3.33)	54	7	20.1	Colour on par with control tea. No off notes

Iron content in End-cup : The iron content in the end-cup was determined using Atomic Absorption Spectroscopy (AAS). 2 gms of the tea of Example 1, containing 3 mg of iron was taken and an infusion was made and then subjected to drying. The residue obtained was ashed and the ash was dissolved in concentrated hydrochloric acid. The solution was analysed for iron using atomic absorption spectroscopy. 1.7mg of iron was detected in the infusion. Hence approximately 60% of the iron added to the tea leaves was found to be present in the cup of tea.

CLAIMS

1. Tea fortified with a stable ferrous-hydrolysed plant protein complex wherein the average molecular weight of the hydrolysed protein is 250D to 5000 D.

2. Tea as claimed in claim 1 wherein the average molecular weight of the hydrolysed protein is between 500 and 5000 D.

3. Tea as claimed in any preceding claim wherein the ratio of the ferrous ion to the hydrolysed plant protein is from 1:3 to 1:13, more preferably from 1:6 to 1: 13, and most preferably from 1:10 to 1:13.

4. Tea as claimed in any preceding claim wherein the hydrolysed plant protein is obtained from protein derived from a cereal or a legume.

5. Tea as claimed in claim 4 wherein the hydrolysed plant protein is obtained from protein derived from wheat, rye, corn, barley or pea.

6. Tea as claimed in any preceding claim wherein the amount of ferrous-hydrolysed plant protein complex added to the tea is sufficient to give 0.15% to 0.3% ferrous ion based on the total weight of the tea solids present.

7. A process to make tea as claimed in any preceding claim comprising the steps of preparing an acidic solution of the hydrolysed plant protein such that the pH is preferably from 1 to 5, adding a ferrous salt to the solution, changing the pH to an alkaline pH, preferably from 6.8 to 10, heating the mixture, optionally drying the mixture to obtain the complex and adding the complex to a tea product.

8. A process as claimed in claim 6 wherein the ferrous salt is ferrous sulphate, ferrous chloride, ferrous citrate, ferrous lactate, ferrous fumarate or mixtures thereof.

9. A process as claimed in claim 6 or claim 7 wherein the optional drying step is a spray drying step

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A23F3/14 A23F3/16 A23L1/304

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A23F A23L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
WPI Data, PAJ, EPO-Internal, FSTA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 00 51447 A (NESTLE SA ;MALLANGI CHANDRASEKHARA REDDY (US); SHER ALEXANDER (US)) 8 September 2000 (2000-09-08) cited in the application page 3, line 22 - line 23; claims 1,21,22,25 page 1, line 26 -page 2, line 4; examples 1,2 ---	1-5,7-9
Y	US 4 216 144 A (ASHMEAD HARVEY H) 5 August 1980 (1980-08-05) cited in the application column 2, line 43 -column 4, line 3; examples 1-3 --- -/--	1-5,7-9

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 00 51446 A (NESTLE SA ;SHER ALEXANDER (US); JACOBSON MARK RANDOLPH (US); VADEH) 8 September 2000 (2000-09-08) cited in the application	
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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